

### **REMARKS**

Claims 1-20 are currently pending in the application. By this amendment, claims 1, 2, 4, 5 and 6 are amended for the Examiner's consideration. The specification is amended to correct minor typographical and grammatical errors. The above amendments do not add new matter to the application and are fully supported by the specification. Reconsideration of the rejected claims in view of the above amendments and the following remarks is respectfully requested.

#### ***Specification***

The specification is amended to correct minor typographical and grammatical errors.

#### ***Allowed Claims***

Applicants appreciate the indication that claims 5 and 7-20 are allowed. However, Applicants submit that all of the claims are in condition for allowance for the following reasons.

#### ***Objection to Claims***

Claim 3 was objected to for being an improper limitation as it sets forth a commercial transaction. This objection is traversed.

Applicants are unaware of any limitations imposed by the rules of the U.S. Patent Office which prohibit the protection of commercial transactions. Applicants submit that an objection is typically used when the claim is improperly dependent on a base claim or intervening claim, and that an objection to the claim based on claim terminology is improper. See MPEP 608.01(n). In any event, Applicants submit that there is proper basis for the features of claim 3 in the description (MPEP 608.01(o), the language is complete and accurate (see, e.g., 2173.03 and 707.07(j)) and that Applicants are unaware of any prohibition of protecting commercial transactions. In fact, the whole body of business method claims, which are clearly permitted by the U.S. Patent Office, are replete with business transaction terminology.

**35 U.S.C. §112 Rejection**

Claims 1, 2, 4 and 6 were rejected under 35 U.S.C. §112, 2<sup>nd</sup> paragraph. This rejection is respectfully traversed. Claims 1, 2, 4 and 6 are amended to clarify the invention. Accordingly, Applicants respectfully request that the rejection over claims 1, 2, 4 and 6 be withdrawn.

**35 U.S.C. §102 Rejection**

Claim 1 was rejected under 35 U.S.C. §102(b) for being anticipated by the reference titled "Technical Progress in the Development of Zero Emission Coal Technologies" by H.J. Ziock et al. (hereinafter referred to as Ziock). This rejection is respectfully traversed.

Applicants submit that none of the prior art that was noted in the background section or disclosed in Applicants' Information Disclosure Statement (including Ziock) offer any technically and economically realistic and safe near term solution to immediately begin arresting the massive CO<sub>2</sub> increases, much less to substantially reducing them beginning in a few years. In sharp contrast, the present invention discloses methods for beginning to achieve major CO<sub>2</sub> reductions from the combustion of coal in existing U.S. and foreign coal fired boilers and for totally eliminated the emissions by sequestration in underground limestone that is about 2% of the earth's crust..

By way of background, in implementations of the invention, CO<sub>2</sub> can be reduced by up to about 20% by firing coal under much more fuel rich conditions than in current use for NO<sub>x</sub> reduction in order to deliberately increase the unburned carbon exhausting from the boilers of furnaces by up to 20%, which will reduce CO<sub>2</sub> by 20%. The unburned carbon mixed with fly ash will be captured in the stack particulate equipment and stored either on-site or at other appropriate sites for future combustion under conditions disclosed in the 2<sup>nd</sup> method that consists of total combustion of the unburned carbon and separation of the CO<sub>2</sub> from N<sub>2</sub>, and its compression with water for pumping underground into limestone formation for permanent CO<sub>2</sub> sequestration by reacting with the limestone and form calcium bicarbonate.

Total removal and in-ground sequestration in the underground limestone formations that consist of 2% of the Earth's crust, which occur at far greater concentrations than all the carbon in the earth. An innovation is reducing the amount of CO<sub>2</sub> needing sequestration by using pyrolysis

of the volatile matter in the coal to convert into hydrogen by reaction with calcium oxide. The remaining coal char is fired in air-cooled slagging combustors that are attached to boilers or furnaces, wherein the pollutants, NO<sub>x</sub>, SO<sub>2</sub>, volatile trace metal, including mercury, arsenic, lead, and dioxins/furans are removed. Pyrolysis of volatiles and char combustion maximizes the partial pressure of CO<sub>2</sub> in the remaining carbon dioxide and nitrogen gas mixture that flows through the boiler or furnace and sharply reduces the compression power at ambient temperatures that is needed to dissolve the CO<sub>2</sub> in water to a pressure high enough to pump the CO<sub>2</sub> to limestone strata (e.g., that exists several 1000 feet underground). The CO<sub>2</sub>-water solution will react with the limestone to form calcium bicarbonate for permanent sequestration. The excess water is recovered, as is the compression energy used for the nitrogen. The hydrogen can be used to power gas turbines, which incredibly can double the power output of existing coal fired power plants, or the H<sub>2</sub> can be used as a chemical feedstock, or a transportation fuel. None of the prior art discloses any these methods for producing hydrogen or for reducing CO<sub>2</sub> emissions. .

Ziock is not relevant to this invention. Ziock's Technical Progress on Zero Emission Coal Technologies is totally irrelevant to the present invention. Basically, Ziock does not confront the CO<sub>2</sub> emission problem. The solutions offered in the case of Ziock would require the developing of a totally new electric production system.

More specifically, claim 1 applies to "energy systems that contain furnaces, boilers, and heat engines", which encompasses all worldwide existing and planned electric power plants. Additionally, the claimed invention is related to very fuel rich process to use unburned carbon to immediately cut CO<sub>2</sub> emissions is unique and immediately applicable to CO<sub>2</sub> education. On the other hand, Ziock's electric power plant consists of fuel cells that are tolerant of sulfur compounds released during coal gasification, which is not only substantially more difficult than hydrogen or methane driven fuel cells, but there are no such central station electric power plants in existence, and even if developed, they would be decades away from significant impact on CO<sub>2</sub> emissions.

Ziock states in paragraph 1 of the paper, line 4 that "The process does not involve any combustion ..nor air emissions". This enables Ziock to operate the process without nitrogen,

which is part of fuel combustion in air, as is clear from Ziock's Figure 2 showing the entire process with no nitrogen. As a result, Ziock can compress the CO<sub>2</sub> into a liquid and ship it to some unspecified "sequestration plant", as shown in Figure 2, and in the text.

The claimed invention, though, applies to existing, conventional fossil fuel power plant. CO<sub>2</sub> and N<sub>2</sub> products of combustion are compressed and mixed with water. N<sub>2</sub> is separated and released to the atmosphere, and the CO<sub>2</sub>-water solution is sequestered in underground limestone formations. Importantly is that the claimed invention takes advantage of the much greater solubility of CO<sub>2</sub> in water over N<sub>2</sub> in water and Henry's Law to compress both gases and then separate them by expanding the very low solubility N<sub>2</sub> and recover its compression power. This makes sequestration of CO<sub>2</sub> from combustion feasible because the large N<sub>2</sub> compression power is recovered. Nowhere is this mentioned as a means to sequester CO<sub>2</sub> in Ziock who does not even use air or N<sub>2</sub>.

Also, Ziock operates a low temperature cycle and as a result the contaminant gases and solids are removed with low temperature liquid processes. The claimed invention, on the other hand, removes the various contaminant gases over the range from peak combustion gas temperature down to ambient conditions, which simplifies the CO<sub>2</sub> sequestration.

Moreover, Ziock "gasifies" all the coal which complicates the process because it requires much more gas processing, also high gas temperatures up to about 3000°F that imposes difficult materials problems, and multiple processes from gasification to methane to hydrogen production. On the other hand, the claimed invention uses pyrolysis of the volatile in the solid fuel to produce hydrogen, which only requires temperatures of only 1500°F to 1800°F that can be implemented with compact high temperature alloy- Inconel 800H tubes in a steel shell recuperative heat exchanger. Also, there is no intermediate CH<sub>4</sub> production step nor the "water shift" CO+H<sub>2</sub> reaction.

Ziock in a footnote to the Section "Coal Compatible Fuel Cells-CCFC", states that "without developing such CCFC, the future of the coal industry is in doubt", which is clear evidence that the entire process is totally inapplicable to coal combustion power systems, as in the claimed invention.

The present invention thus teaches the immediate partial reduction in CO<sub>2</sub> by operating the coal combustors more fuel rich which increases unburned carbon during combustion, thereby allowing the storage of this carbon for future use and sequestration. More important the present invention offers a means for totally removing and sequestering CO<sub>2</sub> underneath or near the coal fired power plants, while producing hydrogen from coal volatile matter. This process applies to essentially all existing coal power plants and it can be applied within a few years.

Accordingly, Applicants respectfully request that the rejection over claim 1 be withdrawn.

### CONCLUSION

Applicants appreciate the indication of allowable subject matter; however, in view of the foregoing amendments and remarks, Applicants submit that all of the claims are patentably distinct from the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue. The Examiner is invited to contact the undersigned at the telephone number listed below, if needed. Applicant hereby makes a written conditional petition for extension of time, if required. Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 19-0089.

Respectfully submitted,



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